Space Weather Technical Forecast

Issued on Friday 21 March 2025 at 01:28 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated M-class flares (R1-R2; Minor-Moderate radio blackouts) throughout. Chance G1-G2/Minor-Moderate Storms throughout, due to CME arrivals, and later a HSS connection.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low, with only C-class flares. There are currently eight numbered sunspot regions on the visible disc, with also several very small and weak unnumbered spots. Of the numbered regions the main ones of note are AR4031 and AR4035, both Dai/beta but relatively modest in size and activity. Remaining regions are small, simple and mainly stable.

A long duration C4.3 flare at 20/1708 UTC occurred from AR4022 before it faded from view, generating an associated CME. Analysis is currently being undertaken to determine any Earth directed potential, although this is considered unlikely due to it's source location close to the west limb. A filament eruption occurred around 20/1823 UTC, from the southeast quadrant, close to centre disc, but currently an associated CME is not visible in available imagery. If a CME is seen to have been generated then a CME would potentially have an Earth directed component.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1, gradually declined from slightly elevated levels to background levels, falling from 490 km/s to around 390 km/s. Density was average to slightly above average. Interplanetary Magnetic Field, Bt, was weak, 6nT or less, with the north-south component, Bz, also weak, ranging between +4 and -4nT, favouring a negative orientation early and late in the period. Phi angle was negative (towards the Sun). throughout. Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at background levels. High energy electron flux (greater than 2 MeV) was mostly at background to moderate. The 24-hour fluence was below the Active threshold. The observed integrated pfu was 2.28e7 at 21/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low activity is expected, with a chance of isolated M-class flares.

Solar Wind / Geomagnetic Activity: There are three potential CMEs which feature in the forecast in the coming days (21-24 Mar), with a possible addition from one of the CME's observed on the 20th. Solar winds are likely to remain mostly at background levels at first, but with slightly elevated

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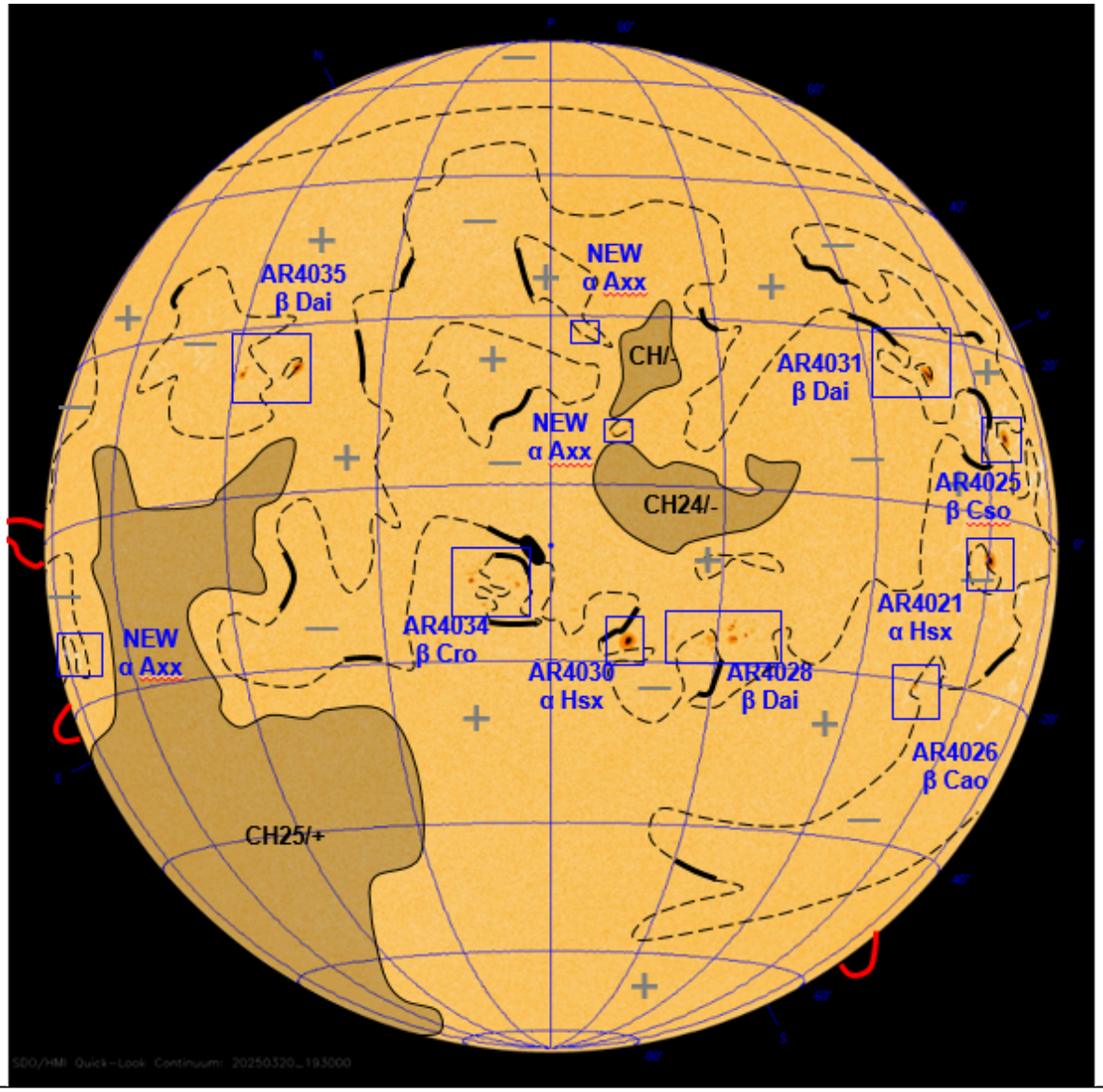
to elevated enhancements possible due to forecast CME arrivals. In addition a further enhancement is possible Day 2 (22 Mar) due to a high speed stream from CH24/-. Generally Quiet activity is expected initially, with a chance of G1-G2/Minor-Moderate storms throughout should any of the possible CMEs arrive, combined with the HSS from CH24.

Energetic Particles / Solar Radiation: High energy proton flux is expected to be at background levels, with a slight chance of enhancement from any larger flares. High energy electron flux is expected to continue at background to moderate levels. Electron (1e8 integrated pfu) fluence should remain below the Active threshold throughout the period.

Figure 1: Synoptic Map valid 20/1930 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are three CMEs which currently feature in the forecast, but with the possible of one or two more once analysis is complete from the filament eruption and CME from the long duration C4.3 flare on the 20th.

The first CME was forecast to give a possible glancing blow late on the 20th Mar, and is likely to have missed, although there is the possibility of a later arrival in combination with the second CME which is due early today (21 Mar). Any arrival is likely to be weak. EPAM observations continue to show a increase in low energy protons, possibly signalling a CME arrival is imminent, although no evidence of a CME arrival has been observed in solar wind data at time of writing.

The third CME was observed leaving the Suns NE limb early on 19 Mar, possibly as a result of a filament eruption from the north-centre disc that occurred around 19/0034 UTC. This has been analysed and results in ENLIL suggest a potential glancing blow at Earth late on Day 2 (22 Mar). Confidence in the CME aspect of the geomagnetic forecast is low due to the number of possible CMEs arrivals, and the possibility of one or more combining in transit, or even missing Earth all together.

Solar winds are expected to be generally at slow to slightly elevated levels over the next few days, perhaps rising with any CME arrival. Further enhancement is then likely from CH24/-, currently in the western hemisphere. A possible high speed stream could arrive at Earth, most likely through Day 2 but perhaps Day 3 (22-23 Mar), with solar winds perhaps reaching elevated levels (500+ km/s).

Generally Quiet activity is expected initially, with a chance of G1-G2/Minor-Moderate storms throughout should any of the possible CMEs arrive, combined with the HSS from CH24.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	30	40	40	20
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
17/1809	Partial	Filament Eruption	Northwest	600	20/1800	Low confidence on exact timing due to interactions with other CMEs. May combine and still arrive.
18/0215	Partial	Filament Eruption	Northeast	520	21/0100	Low confidence. Chance of a glance.
19/1121	Partial	Filament Eruption	North-centre	635	22/1900	Glancing blow from shock possible.

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Figure 2: Latest MOSWOC Enlil.

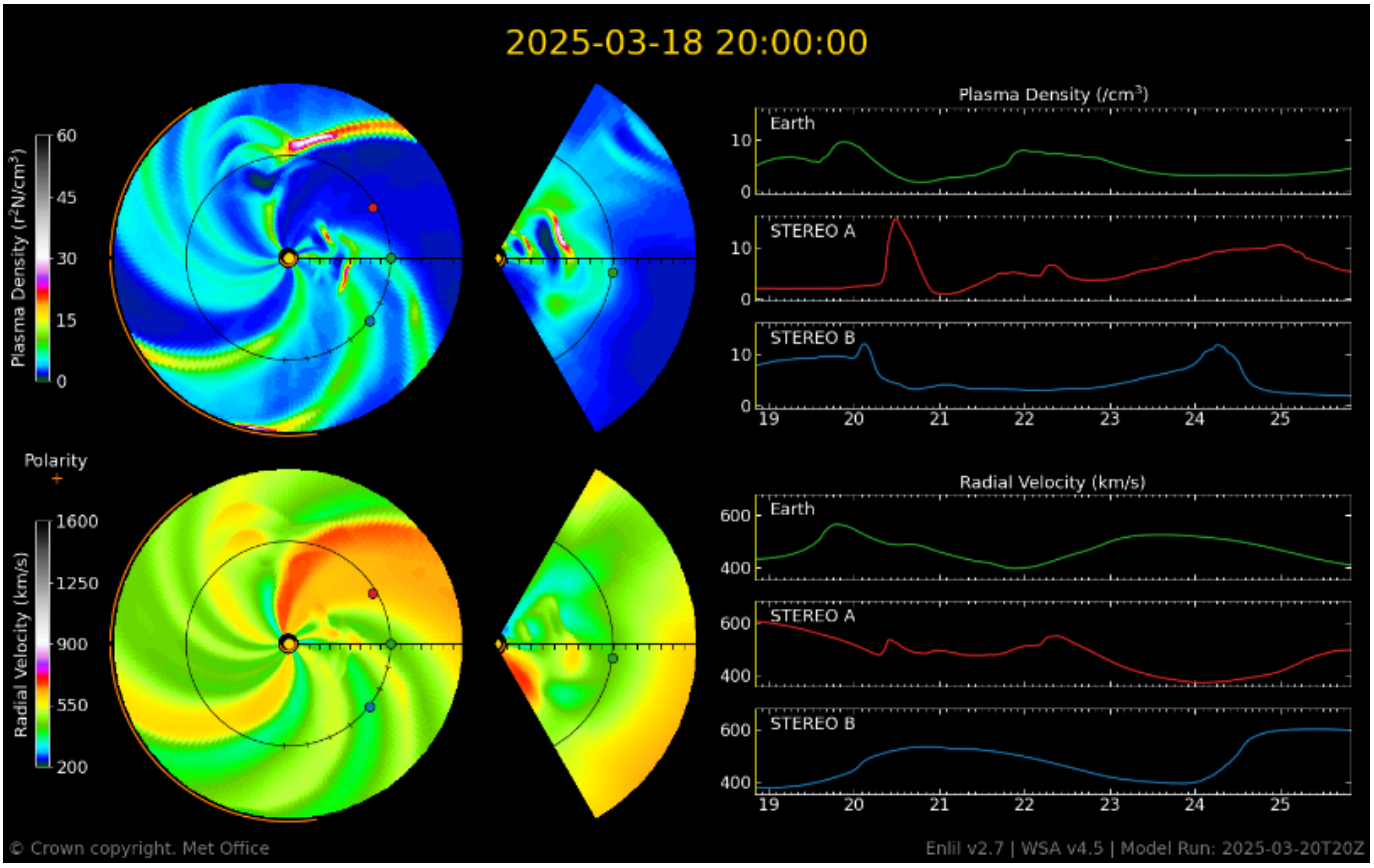

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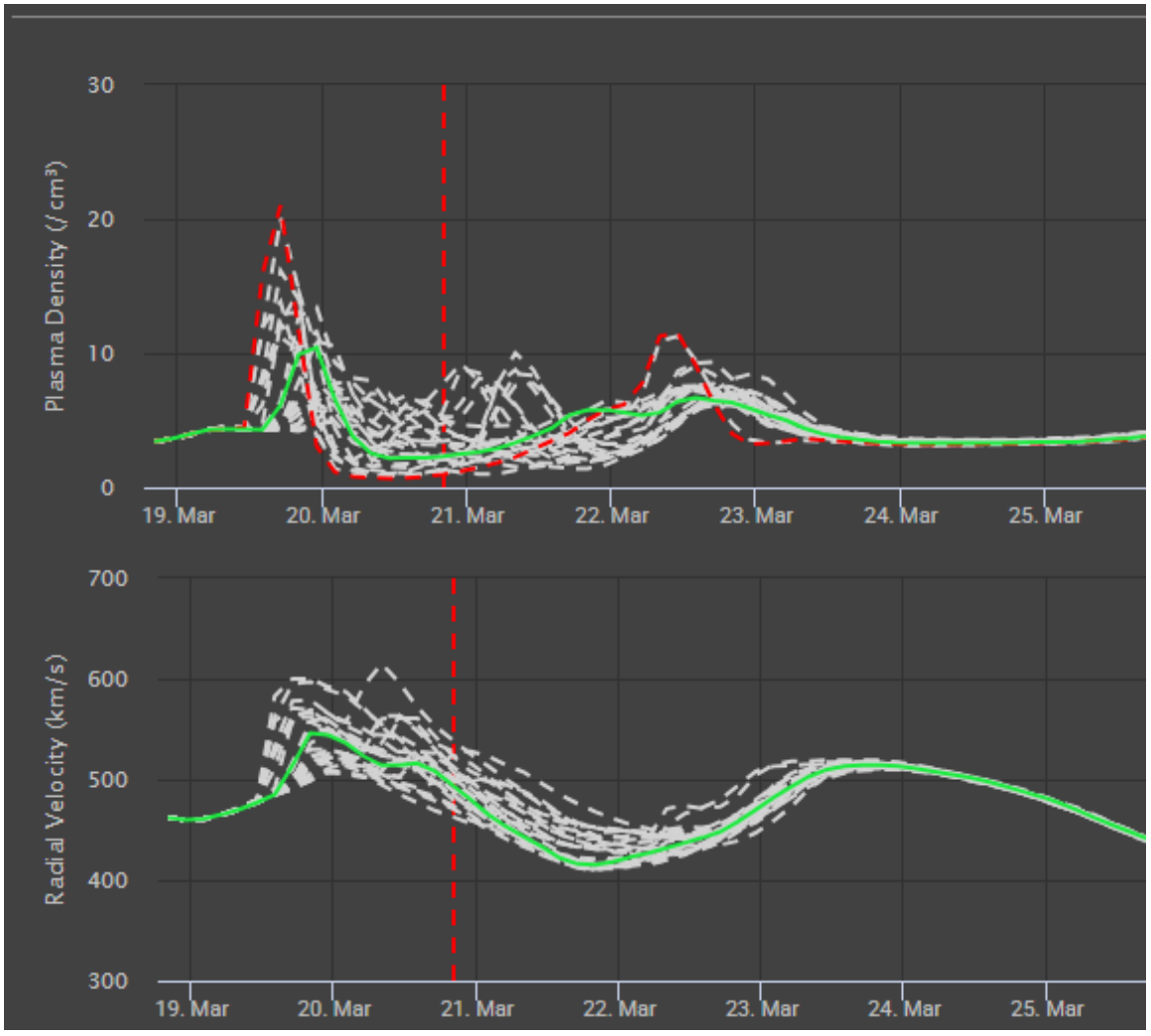
Figure 3: Latest MOSWOC Enlil ensemble.



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Radio Blackouts - X-Ray Flares

Solar activity has been Low, with only C-class flares observed.

There are currently eight numbered sunspot regions on the visible disc, with previous AR4022 now apparently fading to plage, although this may be due to the viewing angle as the region approaches the limb. AR4031 and AR4035 are slightly magnetically complex regions, but still relatively modest in size and activity. Remaining regions are small, simple and mainly stable, including the several unnumbered regions. There are signs that new or returning regions will rotate onto the visible disc through the period, and these may increase the activity levels.

Generally Low activity is expected, with a chance of isolated M-class flares.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	30	30	30	30
Very Active	R3-R5 (X Class)	No	1	1	1	1

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Solar Radiation Storms (High Energy Protons)

GOES18 high energy (>10MeV) proton flux is expected to remain at background levels, with only a slight chance of enhancement due to the current inactivity and magnetic simplicity of the small regions on the Earth-facing disc.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

GOES16 High energy (>2MeV) Electron flux has been at background to moderate. With possible CME arrivals expected over the next few days (21-22 Mar), this may serve to clear some electrons from their orbits, keeping flux at these levels. However, in the absence of any CME arrivals electron flux could return briefly to high levels, especially late in the forecast once a HSS arrives from CH24. Confidence is therefore low due to these uncertainties in the CME forecast.

MOSWOC REFM shows the electron fluence should remain below the Active threshold throughout the remainder of the period, and is considered reasonable guidance, albeit with low confidence as a slightly increasing trend is preferred.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	5	5	10	10
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

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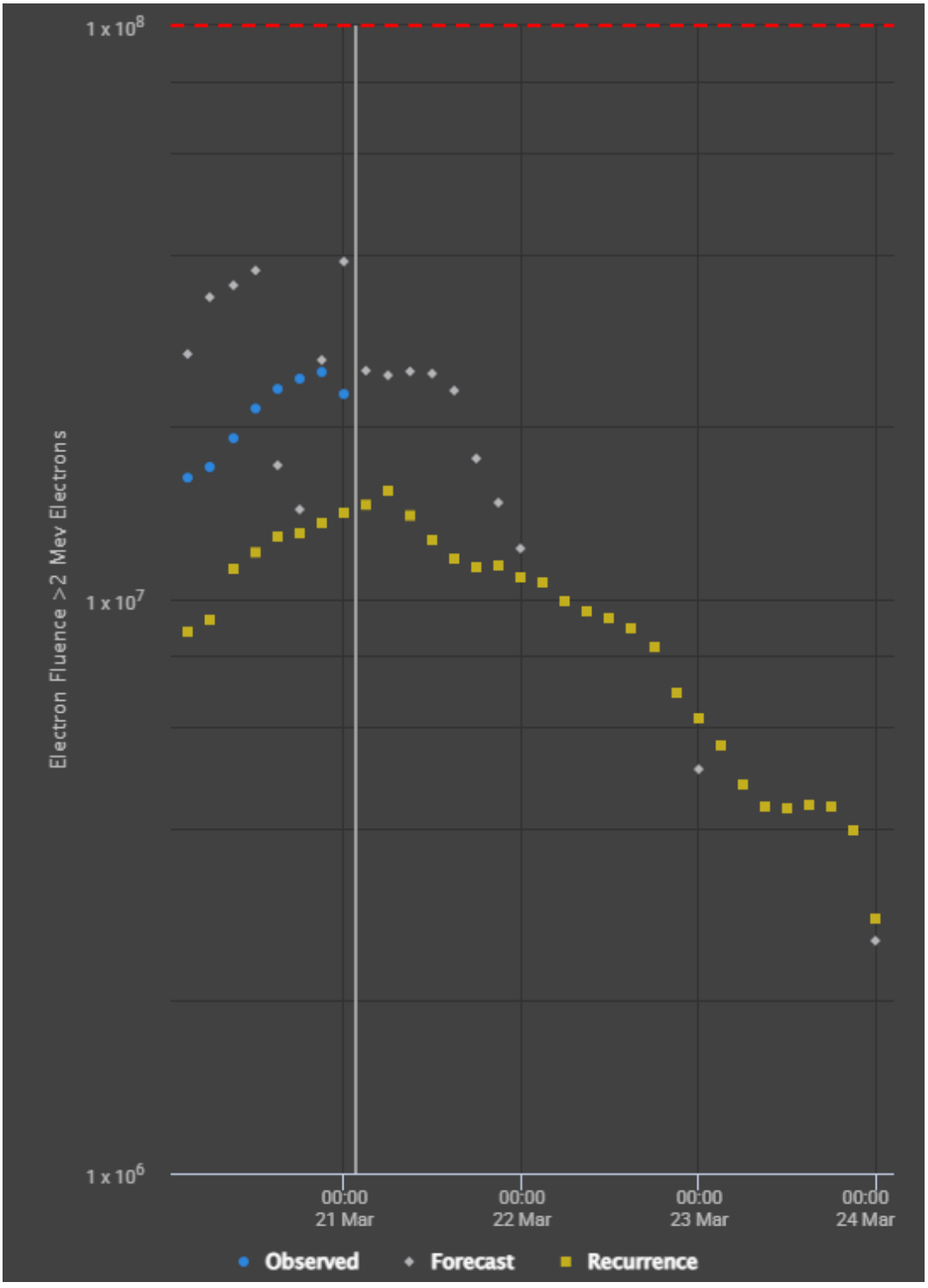
Figure 4: MOSWOC REFM model.



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